

Appendix D:

Attenuation Study

Bradley Man Camp Dumps Removal and On-Site Repository

TCRA Action Work Plan

submitted pursuant to

Administrative Settlement and Order on Consent for Removal Actions

(CERCLA Docket No. 10-2021-0034)

Stibnite Mine Site

Stibnite, Valley County, ID

Prepared for:

U.S. Environmental Protection Agency Region 10

United States Department of Agriculture Forest Service Intermountain Region

Prepared by:



405 S 8th St,
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July 2021



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June 22, 2021

Austin Zinsser
Perpetua Resources Idaho, Inc.
405 S 8th St. #201
Boise, ID 83702

Subject: Evaluation of Cover Options for Mine Waste Repository

Dear Mr. Zinsser:

Valley Science and Engineering (Valley) has prepared this letter report for Perpetua Resources Idaho, Inc. (Perpetua; formerly Midas Gold Idaho, Inc.) to evaluate cover options for a mine waste repository at the Stibnite Gold Project (Project). This report was revised based on a teleconference with Perpetua on June 17, 2021

INTRODUCTION

Perpetua is advancing the Stibnite Gold Project, which would be the 4th largest gold mine and only domestic source of antimony (a strategic metal) in the U.S. The Project is scheduled to take 16 to 23 years for construction, operation and closure. The Project is located in the historic Stibnite Mining District, in Valley County, Idaho, east of McCall.

The Stibnite Mining District was mined extensively by numerous entities between the 1920s and 1990s. Prior mining activities in the Stibnite Mining District resulted in multiple cleanup actions overseen by the US Environmental Protection Agency, US Forest Service, and the Idaho Department of Environmental Quality. Significant legacy tailings, waste rock, and related contamination issues still remain and continue to impact water quality.

Perpetua recently entered into a voluntary agreement to cleanup historic mine waste with the Region 10 Environmental Protection Agency and US Forest Service (Administrative Settlement Agreement and Order on Consent (ASAOC) for Removal Actions, 2021). The Statement of Work referenced in the ASAOC includes 2 removal actions (RAs) that involve placing mine waste in a repository. The Lower Meadow Creek Valley Tailings Removal Project would remove approximately 25,000 tons of tailings and other mine waste from the stream channel and banks of Meadow Creek and the East fork of the South fork of the Salmon River (EFSFSR) and place them in a repository. The NW Bradley Dump Stream Removal and Bank Stabilization Project would remove approximately 200,000 tons of mine waste (primarily waste rock) from the floodplain and banks of the EFSFSR and place them in the same repository.

Objectives

The Statement of Work for the ASAOC requires Perpetua to submit a Time Critical Removal Action Waste Removal and On-Site Repository Work Plan. Perpetua retained Valley to evaluate

and compare the relative effectiveness of covering the repository with soil versus geosynthetic to attenuate the leaching of arsenic.

Approach

Historic mine waste will be removed from waterways and placed in an upland repository to mitigate contaminant release to water resources as much as practicable. The cover on the repository will need to minimize infiltration of precipitation (snowmelt, rainfall) to minimize arsenic leaching from the repository.

Predictions of repository performance for arsenic attenuation was developed with respect to existing conditions and placing waste on the heap leach pads (HLPs) with no cover, a soil cover, and a geosynthetic cover. Leachate flow rates from the repository were predicted by constructing water balances for the repository cover options, using the same approach used for development rock storage facilities (DRSFs) in the overall Stibnite Gold Project (Brown and Caldwell, 2021). Leachate arsenic concentrations were obtained from HLP leachate sampling data and laboratory tests conducted on samples that represent the mine waste to be placed in the repository. Repository cover performance was evaluated as differences between annual average leachate arsenic mass fluxes under steady-state conditions for existing conditions and mine waste cover options.

It was assumed that concentrations of arsenic in the leachate were constant for each cover scenario. For existing conditions, the average concentration of dissolved arsenic in leachate samples were used. For the mine waste cases, the dissolved arsenic concentration was calculated as a depth weighted average of arsenic in leachate from the existing spent ore on the HLPs and arsenic in leachate from mine waste leaching tests.

SITE DESCRIPTION

The repository would be constructed over at a Site that includes 5 existing HLPs. The repository would occupy approximately 8.7 acres (Appendix A). The Site is located on a floodplain approximately 80 to 160 yards north of Meadow Creek extending upstream from the confluence with the East fork of the Salmon River.

The HLPs were constructed in 1982 by Canadian Superior Mining (U.S.), Ltd (Mitchell, 2000). Each HLP is 250 feet wide by 325 feet long, and designed to hold 25,000 to 30,000 tons of ore per pad (Mitchell, 2000). The HLP liners and underdrains that were used to recover leachate for gold recovery are buried. The underdrain conveyance pipes from the heap leach pad to the former collection ponds are also buried, and could have been cut and/or capped. As such, leachate from precipitation (snowmelt, rainfall) that accumulates on the leach pad liner likely overflows the edges of the buried liner and seeps into groundwater.

The pads are currently covered by spent ore that is approximately 15 feet thick. Adding 225,000 tons of excavated mine waste from the response actions (RAs) would increase the height of materials on the heap leach pads to approximately 25 feet.

Subsurface Conditions

Subsurface conditions have been characterized through various investigations associated with environmental concerns and mining at the Site and the former Yellow Pine Mine heap leach operation on the other side of the western property boundary. From the ground surface downward, the following lithologies were observed in 6 borings advanced near the middle and south sides of the Site with permeabilities of saturated lithologies estimated or determined by slug tests in monitoring wells (Hecla Mining Company, 2002):

- 4.5 to 7.5 feet (average 6 feet) of unsaturated sandy gravel fill
- 0 to 6 feet (average 5 feet) of unsaturated tailings with clay to sand textures with low permeability estimated at 10^{-6} to 10^{-7} centimeters per second (cm/s)
- 4 to 8 feet of saturated colluvium/alluvium with measured permeability of 7.54×10^{-4} cm/s
- 25+ feet of saturated glacial till with silty clay to silty gravel textures with measured permeability of 8.1×10^{-4} cm/s
- Bedrock with low permeability estimated at 10^{-6} to 10^{-7} centimeters per second (cm/s)

Groundwater Conditions

There are at least 8 groundwater monitoring wells installed between the Site and Meadow Creek, and 2 wells along the northern Site boundary, as exhibited on maps from past reports (Appendix B) (Hecla Mining Company, 2002; URS Corporation, 2000). Groundwater flows northeast down the Meadow Creek Valley, parallel to the river, with a depth of approximately 12 feet on the southwest corner of the Site to 30 feet on the northeast corner of the Site.

Arsenic concentrations in groundwater decrease in the direction of flow. Median groundwater arsenic concentrations from 2012 to 2017 decreased from 1.5 milligrams per liter (mg/L) at the upgradient edge of the Site to approximately 0.25 mg/L near the downgradient edge of the Site (Midas Gold Idaho Inc., 2019).

Leachate Arsenic Concentrations

Limited water quality data is available for Site HLP leachate. Site HLP leachate samples collected in 2011 from seep YP-M-1 contained an average of 0.39 (0.35 to 0.424) mg/L dissolved arsenic (Perpetua Resources Idaho Inc., 2021).

Laboratory tests were performed to evaluate leachate that may be generated from weathering of tailings and waste rock/spent ore (SRK Consulting Inc., 2017). Leachate from testing 30 samples of Bradley tailings (similar to EFSFSR tailings) by the meteoric water mobility procedure contained a mean of 0.44 mg/L arsenic. Leachate from testing 32 mine waste samples from the Spent Ore Disposal Area (similar to NW Bradley Dump waste) contained 2.2 mg/L arsenic. Long-term humidity cell tests of 3 samples performed for 116 weeks indicated final leachate concentrations of approximately 0.3 to 1.1 mg/L arsenic.

Alluvium Arsenic Attenuation Testing

Unsaturated alluvium column tests supplied with 21 pore volumes over 4 months of mine water containing 5.31 mg/L of arsenic indicated 99% reduction of arsenic concentrations (Environmental Design Engineering, 2002). Groundwater transport modeling of mine water discharged at 130 gallons per minute continuously for 10 years to infiltration galleries, assuming no attenuation of mine water in the alluvium, indicate that the arsenic concentrations would dissipate to background concentrations (0.04 mg/L in 2002) within 1,000 feet downgradient of the infiltration galleries (Environmental Design Engineering, 2002).

REPOSITORY WATER BALANCE PREDICTIONS

Monthly water balances for the repository were constructed using long-term average inputs for precipitation, sublimation, and evaporation. The monthly precipitation and temperature data is based on the Parameter-Elevation Regressions on Independent Slopes Model (Oregon State University - Northwest Alliance for Computational Science and Engineering, 2021) for the period of 1896 to 2019. Annual average values are 32.9 inches precipitation, 4.0 inches sublimation, and 17.3 inches potential evaporation.

Partitioning of precipitation between runoff, infiltration, storage and drainage were calculated based upon hydraulic characteristics of a simple 3-layer monolith that includes the cover materials, mine waste and subgrade fill/alluvium. Hydraulic conductivity inputs for the cover materials were estimated using a federal government-published software application that relies on a large database of soil sample test results (Saxton, K.E. and Rawls, W., 2009). The application does not contain testing data for material coarser than sand. Layer inputs are tabulated below.

Table 1. Water Balance Layer Inputs

Case	Layer	Material	Texture	Thick- ness	Porosity	Field Capacity	Wilting Point	Ksat
	no.			feet		Inches		
Existing Condition	1	Mine Waste	Sand	1.5	0.411	0.059	0.021	4.36
	2	Mine Waste	Sand	13.5	0.411	0.059	0.021	4.36
	3	Alluvium	Loamy Sand	20	0.399	0.085	0.03	1.96
No Cover	1	Mine Waste	Sand	1.5	0.411	0.059	0.021	4.36
	2	Mine Waste	Sand	23.5	0.411	0.059	0.021	4.36
	3	Alluvium	Loamy Sand	20	0.399	0.085	0.03	1.96
Soil Cover	1	Soil	Silty Clay	1.5	0.532	0.416	0.278	0.15
	2	Spent ore	Sand	25	0.411	0.059	0.021	4.36
	3	Alluvium	Loamy Sand	20	0.399	0.085	0.03	1.96

Case	Layer	Material	Texture	Thick-ness	Porosity	Field Capacity	Wilting Point	Ksat
	no.			feet				
Geo-Synthetic Cover	1	Geosynthetic membrane	n/a	0.1	n/a	n/a	n/a	1.42 ×E-5
	2	Spent ore	Sand	25	0.411	0.059	0.021	4.36
	3	Alluvium	Loamy Sand	20	0.399	0.085	0.03	1.96

NOTE:

Abbreviations: in/hr = inches per hour, Ksat = saturated hydraulic conductivity, no. = number.

The water balance results are summarized below while the calculation spreadsheets can be provided electronically upon request.

Table 2. Long-Term Average Annual Water Balance Summary Results

Parameter	Existing Condition		No Cover		Soil Cover		Geosynthetic Cover	
	inches	%	inches	%	inches	%	inches	%
Runoff	0.0	0	0.0	0	0.0	0	28.0	85.1
Sublimation	4.0	12	4.0	12	4.0	12	4.0	12.3
Evaporation	9.9	30	9.9	30	11.9	30	0.8	2.3
Drainage	19.0	58	19.0	58	8.4	58	0.1	0.3

ARSENIC ATTENUATION ANALYSIS

The dissolved arsenic concentration in leachate from 15 feet of spent ore stacked on the existing HLPs is typically 0.39 mg/L, based upon sample analyses. The dissolved arsenic concentration that would leach from 10 feet of mine waste placed on top of the spent ore was calculated as a weighted average of 2.0 mg/L from the meteoric water mobility procedure tests (11% tailings at 0.44 mg/L and 89% waste rock at 2.2 mg/L). The depth-weighted average arsenic concentration in leachate from the repository would be 1.0 mg/L (60% spent ore at 0.39 mg/L and 40% imported mine waste at 2.0 mg/L).

The average annual mass flux of arsenic from the existing condition and mine waste cover alternatives was calculated by the following equation:

$$\text{Mass Flux, pounds} = \text{Drainage (variable, inches)} \times \text{Area (8.7 acres)} \times 226,611 \text{ pounds/acre-inch of water} \times \text{concentration (ppm)} / 1,000,000$$

The arsenic mass flux results for the repository cover scenarios are tabulated below.

Table 3. Annual Average Mass Flux of Arsenic

Case	Drainage	Arsenic Mass Flux	Change from Existing Condition	Change from No Cover
	inches	pounds	%	
Existing Condition	19.0	14.6	n/a	n/a
No Cover	19.0	74.9	+413	n/a
Soil Cover	8.4	33.1	+127	-56
Geosynthetic Cover	0.1	0.4	-97	-99

NOTE:

Abbreviation: n/a = no change.

CONCLUSIONS

The results of this arsenic attenuation analysis indicate that arsenic-leaching losses from the repository using an 18-inch thick soil cover would could increase arsenic leaching by 413% compared to the existing condition but reduce arsenic leaching by 56% compared to adding mine waste with no cover. However, a geosynthetic membrane cover could potentially mitigate arsenic leaching from the imported mine waste by 99% compared to no cover, and also mitigate arsenic leaching under the existing conditions.

Please contact me with any questions or concerns.

VALLEY SCIENCE AND ENGINEERING



Dan Bruner, PG
Managing Geologist

DJB/jbk

Att: Appendices A, B

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REFERENCES

- Administrative Settlement Agreement and Order on Consent (ASAOC) for Removal Actions, CERCLA Docket No. 10-2021-0034 (January 15, 2021).
- Brown and Caldwell. (2021). *Stibnite gold project site-wide water balance model refined modified proposed action (ModPRO2) Report*.
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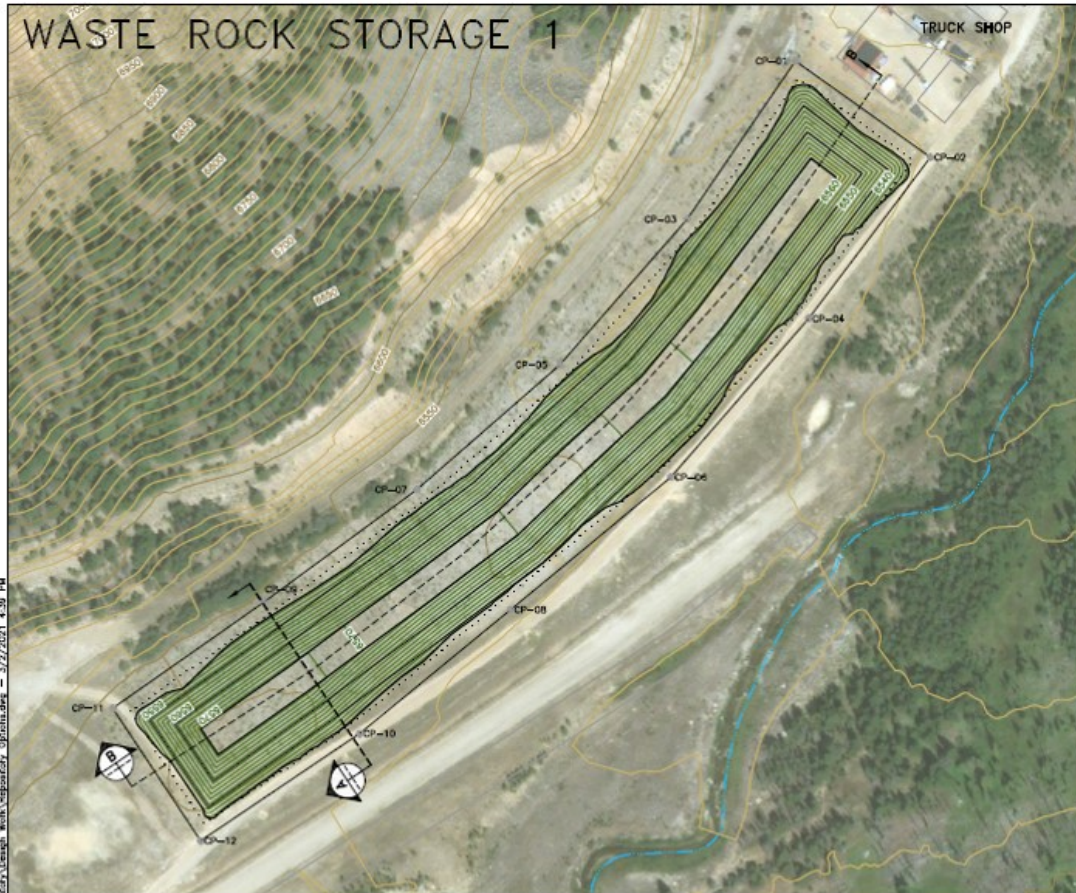
APPENDICES

- Appendix A. Repository Layout Drawing**
- Appendix B. Site Maps from Prior Reports**

Appendix A.

Repository Layout Drawing

WASTE ROCK STORAGE 1



LEGEND:

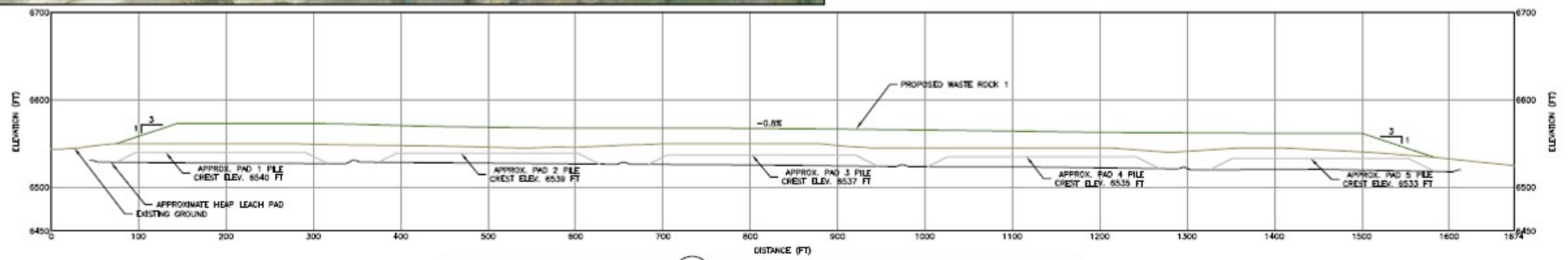
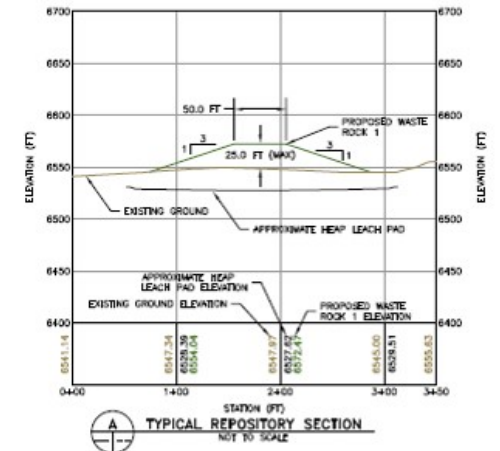
- 7000 EXISTING CONTOURS
- 7000 PROPOSED REPOSITORY CONTOURS
- APPROXIMATE HEAP LEACH PAD LIMIT
- PROPOSED REPOSITORY WASTE ROCK BREAKLINES
- 20.0 FT HEAP LEACH PAD INSIDE OFFSET
- EXISTING ROADS
- EXISTING DRAINAGE
- CONTROL POINT

CONTROL POINTS		
POINT	NORTHING	EASTING ELEVATION
CP-01	1179585.47	2733363.73 6519.00
CP-02	1179430.90	2733580.35 6521.00
CP-03	1179331.56	2733190.42 6522.00
CP-04	1179172.04	2733384.87 6524.50
CP-05	1179098.28	2732985.22 6525.00
CP-06	1178917.77	2733164.24 6526.50
CP-07	1178898.06	2732756.85 6528.00
CP-08	1178705.05	2732907.02 6529.55
CP-09	1178717.38	2732511.38 6531.00
CP-10	1178508.19	2732864.82 6531.00
CP-11	1178547.07	2732288.86 6531.00
CP-12	1178334.20	2732409.83 6531.00

TAILINGS VOLUME = 133,442.44 YD³
 = 216,176.75 TONS (@ 120 pcf)

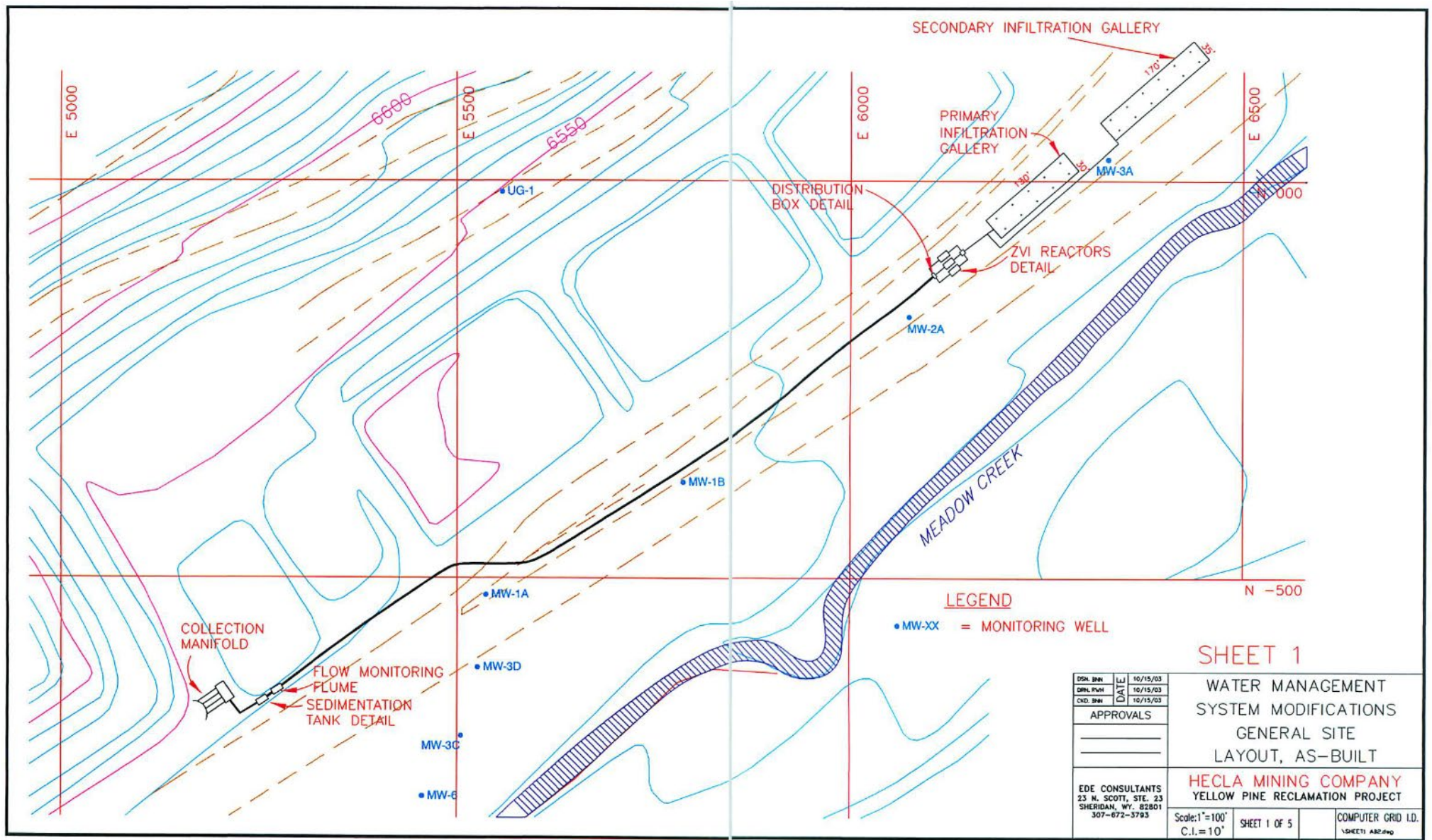


SCALE (FT)
 0 100 200
 CONTOUR INTERVAL: 10 FT
 REPOSITORY CONTOUR INTERVAL: 2 FT



Appendix B.

Site Maps from Prior Reports



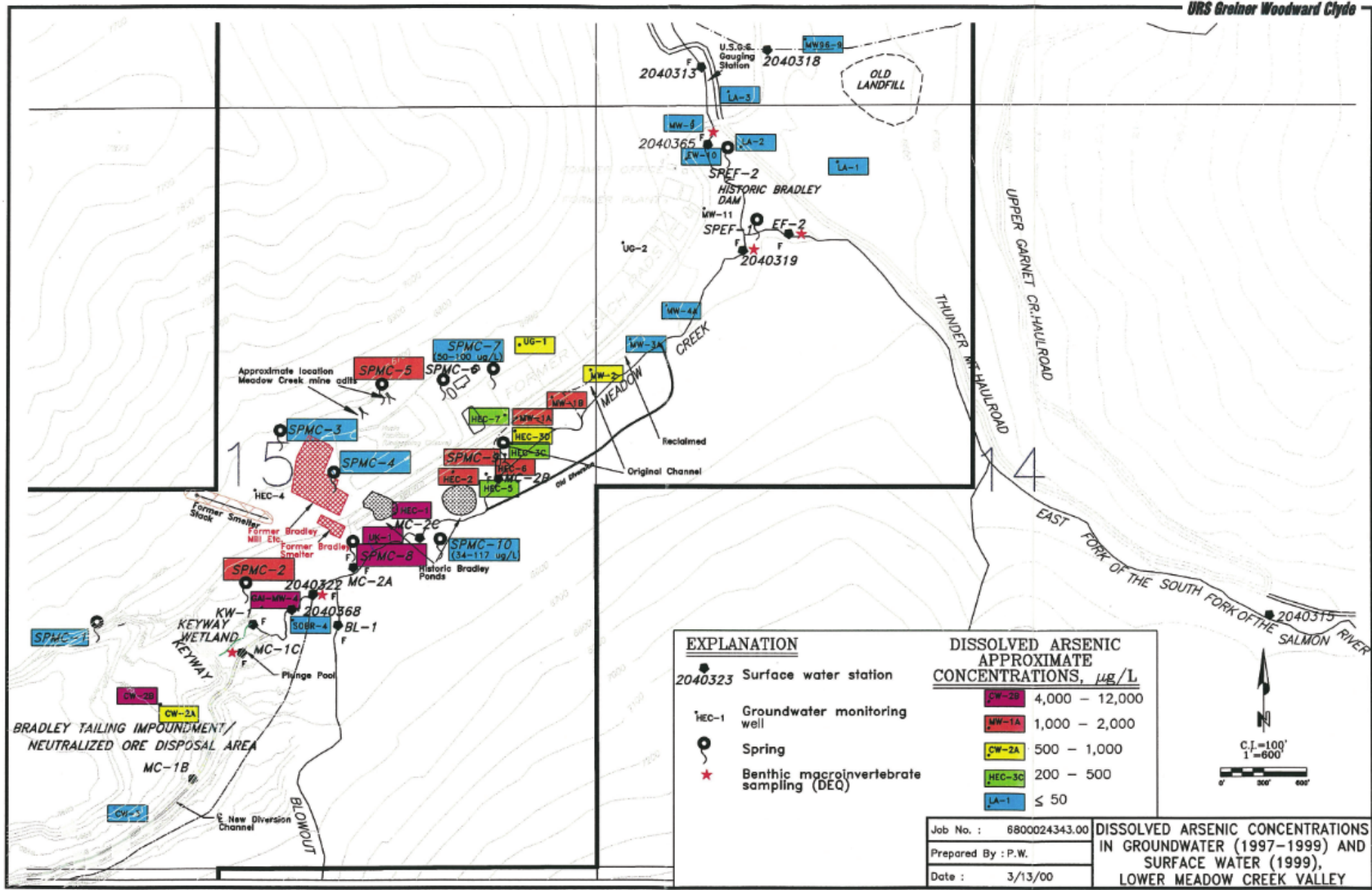


FIG. 8.2-4